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30. 09. 2005

(61)

OBJET : Soumission du 28 mars 2005
N° de demande PCT : PCT/EP2005/051405
Notre référence : E-QUANTC/02

Monsieur,

Veuillez trouver ci-joint la copie officielle de la demande de brevet INPI N° 0403904 du 13 avril 2004 ayant pour titre :
Procédé et Appareillage pour communiquer à distance en utilisant des nucléides isomères.

Veuillez agréer, Monsieur, l'assurance de mes sentiments distingués.

R. Desbrandes

PCT/EP2005/051405

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The Head of the Patent Department

[signed]

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DESBRANDES Robert
Allée des Chériniers
03190 GIVARLAIS

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ou demande de certificat d'utilité initiale	N°	Date
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3 TITRE DE L'INVENTION (200 caractères ou espaces maximum)

Procédé et Appareillage pour communiquer à distance en utilisant des nucléides isomères.

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The present invention relates to a method and an equipment to remotely communicate by using isomer nuclides.

Some nuclides have a metastable state. These states are isomers, i.e. excited states of the nucleus of the atom. The isomers return in their ground state by isomeric transition while emitting a gamma radiation. The isomeric transition, like internal conversion, does not give place to a change of atomic number. In its normal state, an isomer returns in its ground state with an exponential law like the other radioactive elements. This exponential law is generally characterized by the half-life of the radioactive element. The half-life is related to the probability of deexcitation by the formula:

$$P = LN\ (2)\ /\lambda$$

P, probability of disintegration per minutes;
LN, natural logarithm;
λ, half-life in minutes.

For example, the half-life of normal indium 115^m is 268 minutes. The probability of deexcitation of a nucleus per minutes is 0.00258 which represents one chance on 387 per minute. By normal indium 115^m, one indicates a classically excited isomer.

There are indeed several ways of exciting nuclides likely to have a metastable state. It can be excited by neutron irradiation or simply come from the disintegration of a heavier nucleus. It was announced in another invention that the excitation can also take place by reverse isomeric transition with gamma irradiation. When this excitation is caused by gamma emitted by the same nucleus in a cascade, the half-life varies with time instead of being constant. A similar phenomenon but even more important is obtained with gamma obtained by Bremsstrahlung with the particle accelerators.

This invention rests on experiments made with a

source of Cobalt 60 of which each nucleus has the characteristic to emit in a cascade two gamma with sufficient energy to excite Indium 115. Other measurements were made by exciting Indium 115 with gamma coming from a compact linear accelerator. The gamma spectrum extends from 0 to 6 MeV, but is maximum at about 1.5 MeV, i.e. that, in majority, three or four gamma are emitted in a cascade by the same electron, when the accelerator uses electrons.

It is known to the experts that the deexcitation of an isomer can be accelerated by X-ray or gamma irradiation. In this invention this property will be used.

The invention consists in irradiating by the method described previously, and simultaneously, two or several samples of the same element that are likely to have a metastable state. One will consider initially two samples. The two samples are then separated in space by a large distance from at least 10 meters. One of the samples which we will call “master” is excited using x-rays or gamma, whereas the other, “the slave”, is in a steel, lead, and copper enclosure. One measures the gamma activity in particular for the energy of the isomeric transition on the slave sample. A diagram of this implementation is illustrated on Figure 1. A enclosure (1) with a thickness of 3 mm of copper, 15 cm of lead, and 12 mm steel contains the counter of gamma (10) and the slave sample (8), which emits gamma (9) naturally. With a distance of 12 m (7), the master sample (4) is irradiated by the source of Iron 55 (2), which emits gamma rays and x-rays (3). The stimulation, well-known of the experts, occurs and additional gamma rays (5) are emitted by the master sample (4). At the same time, the stimulation of the master sample causes an additional emission of the slave sample (8) although it is inside its thick shielding and located 12 m away from the master sample.

Figure 2 is an example of measurements made on Indium sheets with 99.999% of purity, irradiated linear beforehand and simultaneously during 20 minutes with a compact linear accelerator. The source of x-ray and gamma, Iron 55, was placed during 5 minutes on the master sample, noted “YES” then withdrawn during 5 minutes, noted “NO”, and so on. Measurements of Figure 2 represent the total counting during the 5 minutes of irradiation of the master sample, the 5 minutes without irradiation and so on. An important signal on the slave sample is obtained for the periods of irradiation of the master sample, except the last period for which no signal was obtained. The same experiments made with the source of Cobalt 60 give identical results but hardly higher than the noise.

The present invention can be implemented with nuclides of various half-lives. Indeed, the half-lives of the metastable nuclides usable for this invention extend from one second to 50 years. Table 1 gives a list of the main nuclides which have a metastable state. Their symbol, abundance, half-life with ordinary excitation and isomeric energy of transition are mentioned. The excited samples can be transferred to large distances and wait long periods while being always suitable for being deexcited.

The reported experiments concern a master sample and a slave sample, but a master sample can deexcite a plurality of slaves samples if a plurality of samples were excited together. In the same way, a slave sample can receive a signal of any master sample. It seems that the action occurs whatever the distance or the materials which separate master and slave. This invention thus solves a technical problem of transmission of information, for the moment very crude, but nevertheless, it is a great innovation.

Various industrial applications are immediately

possible, signals of distress in the mines, sea floors, etc. Medical applications are also possible by remotely stimulating the isomer which was placed close to, or in the organ to be treated.

The invention which will be thereafter detailed is not explained by the current scientific theories. Consequently, it does not result of a technique known by the experts.

The method, according to the invention, consists in using gamma rays for irradiating two or several samples of an element with a metastable state, this metastable state having a half-life comprised of less than one second to several years. The gamma rays used for the excitation of the samples must come either from a disintegration in a cascade in the case of a radioactive isotope, or of the Bremsstrahlung effect in which the same particle emits several gamma.

For example, an emission in a cascade is provided by Cobalt 60. The emitted gamma rays must have a sufficient energy to carry out an isomeric reverse transition, i.e. to make the nucleus go from its ground state to a metastable state. In the case of Indium 115, for example, the energy necessary for the threshold of excitation is of 1,080 keV, condition which is met by the two gamma rays of Cobalt 60. One of the gamma has an energy of 1,173 keV with 99.90% of chances to occur, and the other 1,332 keV with 99.98% of chances to occur. We have certainly a cascade because the two gamma are emitted at a 0.713 picosecond (10^{-12} second) interval on average.

In the case of an irradiation by the Bremsstrahlung gamma rays of a linear accelerator of particles, for example of electrons, the gamma energy must again be higher than the threshold of excitation of the selected element.

For example, a compact linear accelerator can emit a

gamma radiation very focused with a spectrum of gamma energy extending from 0 to 6 MeV. If the energy of all the electrons before meeting the tungsten target is 6 MeV, each electron emits on average four gamma of 1.5 MeV (1,500 keV) in a very fast succession comparable to a cascade. This cascade of gamma of the accelerator is, as the experiment shows, more efficient to carry out the work described in this invention.

According to a particular mode of the invention represented on Figure 3, which relates to an irradiation with a radioactive source emitting gamma in a cascade, the samples to be irradiated are placed in couple or more on the tray (11) which presents the groups of samples (12) in succession in front of a piston (16) which introduces them opposite a radioactive source (14) by the opening (15) using the piston. The source is placed in a thick steel and lead shielding (17). An axis (18) connects the tray to a stepper motor (19) controlled by a timer (20). The time of irradiation is adjusted for each group of samples using a timer (21) which actuates a pneumatic valve (22) to obtain the optimal response of activation. In the case of Indium 115, with a source of 111,000 GBq (3,000 Ci), several hours of excitation are necessary.

According to another mode of implementation of the invention, schematized on Figure 4, the groups of samples (23) are placed on a turning tray (24). This tray is supported by an axis (25) that is connected to a stepper motor (26), itself controlled by a timer (27). The groups of samples are presented one after the other in front of the beam of x-rays of a compact linear accelerator (28) for example. A “phantom” (29) filled with water stops the gamma rays not absorbed. In general the accelerators cannot function permanently. A certain number of units of time of irradiation, for example of 5 minutes, will be applied to

each sample to obtain the optimal excitation using a timer (30). In the case of Indium 115, a 20 minutes excitation with a compact linear accelerator is enough to have a satisfactory signal to noise ratio.

An ordered ensemble of independent couples of samples can also be irradiated, as shown in the figure 5. On this figure, the couples of samples are laid out on two disks, the master disk (31) and the slave disk (32), during the irradiations. The other elements of Figure 5 are identical to those of Figure 4. These disks can then be separated at any distance and exploited by stimulation of modulated deexcitation of each ordered sample of the master disk and the reception of this modulation by the sample corresponding of the slave disk, the transmission of a complex message is thus allowed. If several samples, placed in several disks, are excited together instead of a mere couple of disks, the message can be transmitted simultaneously to several slaves disks. Other supports that disks can be used. For example, platelets presented in translation in front of the generator of gamma emitted in a cascade.

The pieces of equipment described previously are examples of implementation. Other means to present the samples to the irradiation can be employed without leaving the framework of the invention.

The master-slave groups of samples to be irradiated are solids in sheet or powder, fluids or gases (case of Xenon for example) which contain a proportion of one or several isotopes for example mentioned in Table 1. The samples can also be alloys, mixtures or chemical compounds incorporating a proportion of one or several isotopes of Table 1. The samples of a same group can be of different nature, for example one in powder and the other in sheet. One or more of the samples of the same group can also be

transformed physically or chemically after irradiation, the sample slave in the form of powder or of gas can be incorporated in an injectable carrying molecule for example. The isomer or a salt containing the isomer can also be put in solution in the sample. An isomer plurality can be employed in this solution.

Measurements of gamma due to the isomeric transition from the slave during the stimulation of the master can be taken with the conventional instruments of the expert. A common instrument is the detector functioning with germanium crystals at low temperature. In order to minimize the effects of the cosmic rays, radon and the ambient interferences, the sample slave is placed in an enclosure with walls of copper, lead and steel, located at a long distance from the main sample (12 m in the reported experiment). A multi-channel analyzer must be able to be set on the radiation characteristic of selected isomer. For example, in the case of Indium 115^m, gamma in the 336.2 keV line are counted. It is also possible that progress of the technique makes it possible to measure the radiation of 336 keV without having a special enclosure.

A temporal modulation of stimulations of deexcitation, as the example of Figure 2 shows it, can be used to send a message made up of “yes” and of “no”, i.e. composed of 1 and 0 in binary language, on one or a plurality of samples. More complex modulations of the stimulations of deexcitation, such as frequency modulation or amplitude modulation, can also be used.

According to known techniques of stimulation of isomers, one can choose the optimal radiation to stimulate a particular isomer. Consequently, the main sample containing a mixture of isomers can be selectively excited. Each isomer thus represents in this case a particular “channel” of transmission.

When the isomer emits, naturally or during remote stimulation, gamma of several energy, the measurements made for each energy make it possible to improve the signal to noise ratio.

CLAIMS

1) Method and equipment to communicate or control a remote deexcitation by using isomer nuclides, characterized by the irradiation of several samples of an element having a metastable state by a source of gamma rays emitted in a cascade, either by a radioactive source, or by a generator of gamma rays coming from Bremsstrahlung of accelerated particles, with a sufficient energy to excite the aforementioned element in its metastable state, and to stimulate the deexcitation of one of the samples, the “master”, which causes the deexcitation of the other samples, the “slaves”, located at any distance, in any medium.

2) Method and equipment according to claim 1 characterized by the use of a plurality of samples, irradiated together, the modulated stimulation of the master being received by the slaves.

3) Method and equipment according to claim 2 characterized by the use of samples containing one or more isotopes mentioned in Table 1.

4) Method and equipment according to claim 2 characterized by the use of samples in various physical forms.

5) Method and equipment according to claim 2 characterized by the use of samples in various chemical forms.

6) Method and equipment according to claim 2 characterized by the use of a group of samples containing different isomers.

7) Method and equipment according to claim 2

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CLAIMS

1) Method to communicate or control a remote deexcitation by using isomer nuclides, in which:

- one prepares two or several samples containing at least one isomer nuclide having a metastable state by irradiation with the means either of a source of gamma rays emitted in a cascade, or of a generator of gamma rays coming from Bremsstrahlung of accelerated particles, with a sufficient energy to excite the aforementioned isomer nuclide in its metastable state,
- one causes the modulated stimulation of the deexcitation by irradiation X or gamma of one or more of the aforementioned samples, the master or the masters,

characterized in that one obtains an additional modulated deexcitation of the other samples, the slaves, during the modulated stimulation of the deexcitation of the master sample or of the master samples, independently of the distances separating the samples, and the mediums separating these samples or in which they are placed.

2) Method according to claim 1 characterized in that one uses samples containing at least one isomer nuclide having one metastable state with a half-life duration of less than one second to several years, for example: Niobium (93Nb41m), Cadmium (111Cd48m), Cadmium (113Cd48m), Cesium (135Ce55m), Indium (115In49m), Tin (117Sn50m), Tin (119Sn50m), Tellurium (125Te52m), Xenon (129Xe54m), Xenon (131Xe54m), Hafnium (178Hf72m), Hafnium (179Hf72m), Iridium (193Ir77m), Platinum (195Pt78m).

3) Method according to anyone of the claims 1 or 2 characterized in that one uses samples containing several

characterized by the use of a group of samples of which one at least underwent a physical transformation after irradiation.

8) Method and equipment according to claim 2 characterized by the use of a group of samples of which one at least underwent a chemical conversion after irradiation.

9) Method and equipment according to claim 2 characterized by the use of at least one master sample and at least one slave sample.

10) Method and equipment according to claim 2 characterized by the use of at least one sample made up of isomers which emits gamma of different energy at the time of the deexcitation.

11) Method and equipment according to claim 2 characterized by the use of a stimulation modulated in amplitude of at least one master sample.

12) Method and equipment according to claim 2 characterized by the use of a stimulation modulated in time and applied to at least one master sample.

13) Method and equipment according to claim 2 characterized by the use of a plurality of samples placed on at least two identical supports

14) Method and equipment according to claim 13 characterized by the use of a plurality of samples used in a sequence to transmit a complex message.

excited isomer nuclides of which the gamma response of each one of them is measured simultaneously.

4) Method according to anyone of the claims 1, 2 or 3 characterized in that one uses samples containing at least one excited isomer nuclide of which the gamma response is made up of a plurality of lines measured simultaneously.

5) Method according to anyone of the claims 1, 2, 3 or 4 characterized in that one uses samples in various physical forms or various chemical forms.

6) Method according to anyone of the claims 1, 2, 3, 4 or 5 characterized in that one uses a group of samples of which one at least underwent a physical or chemical transformation after irradiation.

7) Method according to anyone of the claims 1, 2, 3, 4, 5 or 6 characterized in that it one uses a stimulation modulated in amplitude of at least a master sample.

8) Method according to anyone of the claims 1, 2, 3, 4, 5, 6 or 7 characterized in that one uses a stimulation modulated in the time of at least one master sample.

9) Device of implementation of the method according to anyone of claims 1 to 8 characterized in that it includes:

- An apparatus of excitation irradiating two or several samples containing at least one isomer nuclide having a metastable state with the means either of a source of gamma rays emitted in a cascade, or of a generator of gamma rays coming from Bremsstrahlung of accelerated particles, with a sufficient energy to excite the aforementioned isomer nuclide in its metastable state,
- One or more apparatuses of modulated stimulation deexciting by X-ray or gamma irradiation one or more of the samples irradiated previously, the master or

the masters,

- One or more apparatuses of detection measuring the gamma rays emitted by one or more of the other samples irradiated previously, the slave or the slaves.

10) Device according to claim 9 characterized in that the samples of each group are laid out on only one support in the apparatus of excitation, thereafter being separated and being positioned in relation to each other in the apparatus or in the apparatuses of modulated stimulation and in the apparatus or the apparatuses of detection.

11) Device according to claim 9 characterized in that the samples of each group are laid out on a plurality of supports in the apparatus of excitation, the supports being thereafter separated and positioned in synchronous relation to each other in the apparatus or the apparatuses of modulated stimulation and in the apparatus or the apparatuses of detection.

12) Device according to one of the claims 9, 10 or 11 characterized in that the groups of samples is arranged according to a definite scheduling allowing the transmission of complex messages.

13) Use of the method according to anyone of claims 1 to 8 to remotely transmit information, in particular emergency signals.

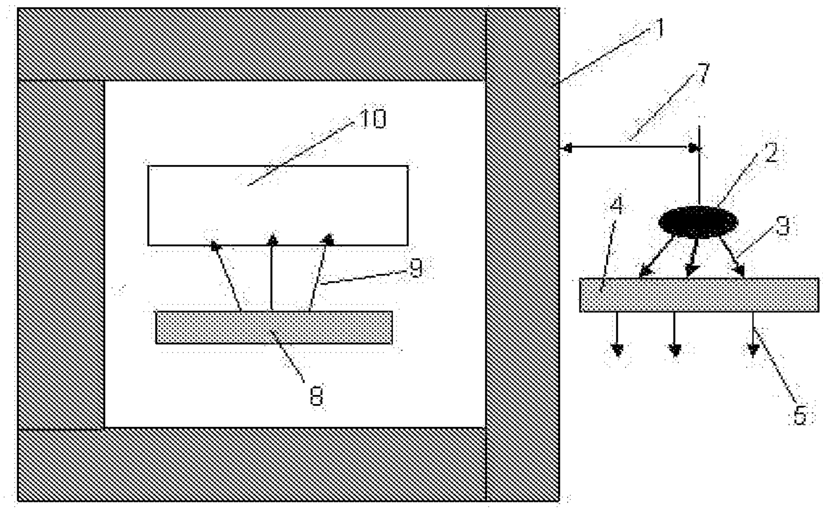
1
7
10
2
4
9
9
8
5

FIG. 1

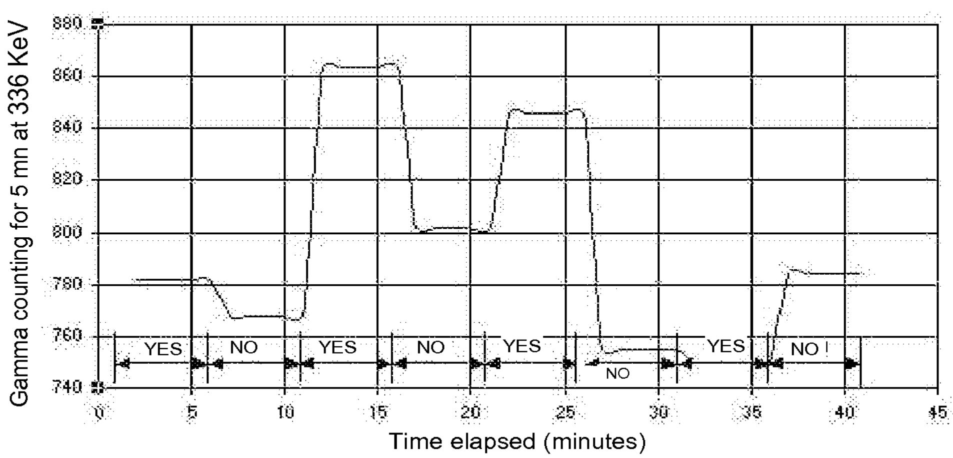
Gamma counting for 5 mn at 336 KeV
880
860
840
820
800
780
760
740
YES
NO
YES
NO
YES
NO
YES
NO
0
5
10
15
20
25
30
35
40
45
Time elapsed (minutes)

FIG. 2

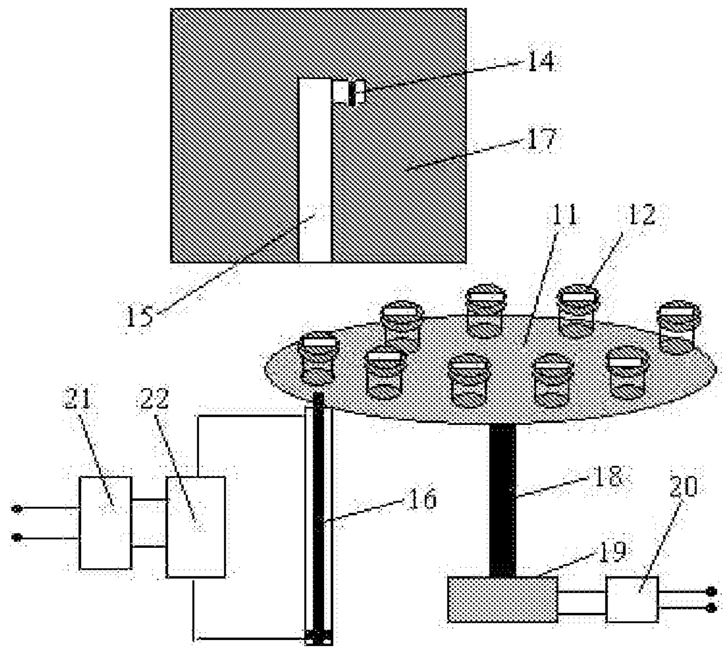

FIG.3

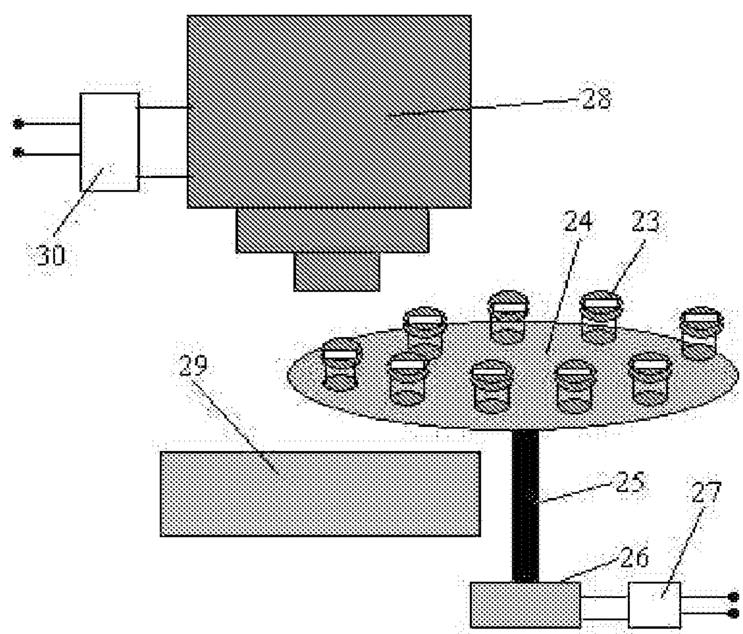

FIG.4

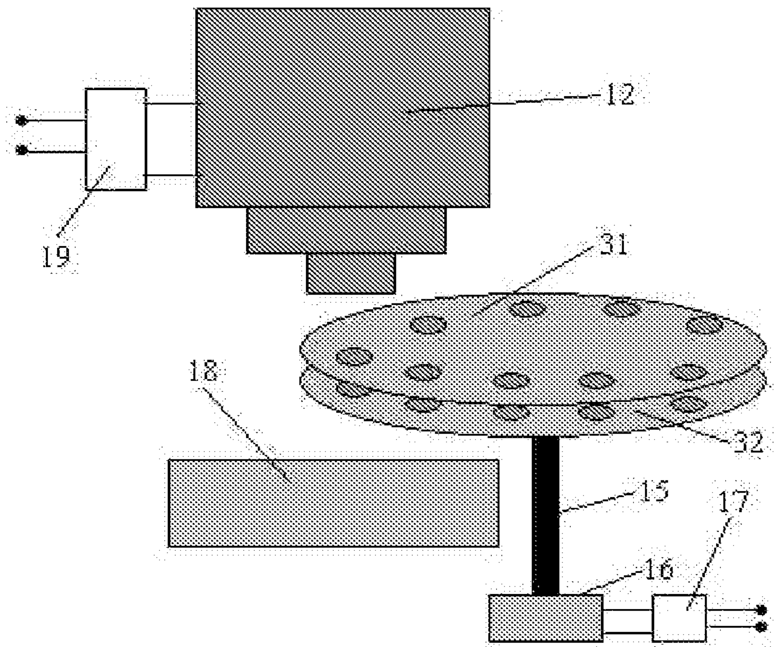

FIG.5

Nuclide	Symbol	Abundance %	Half-life	Gamma keV
Niobium	93Nb41	100	16.3 y	31.8
Cadmium	111Cd48	12.8	48.54 m	396.2
Cadmium	113Cd48	12.2	14.1 y	263.5
Cesium	135Ce	-	53 m	846/786
Indium	115In49	95.7	4.48 h	336.2
Tin	117Sn50	7.7	13.6 y	314.6
Tin	119Sn50	8.6	293 d	60.5
Tellurium	125Te52	7.1	57.4 d	144.8
Xenon	129Xe54	26.5	8.8 d	238.1
Xenon	131Xe54	21.2	11.8 d	163.9
Hafnium	178Hf72	27.3	31 y	574/…./93
Hafnium	179Hf72	13.6	25 d	453/…./122
Iridium	193Ir77	62.7	10.5 d	80.2
Platinum	195Pt78	33.8	4 d	259.3

m: minutes, h: hours, d: days, y: years.

TABLE 1

I certify that this document is the English translation, to the best of my knowledge, of the document referenced in the first page.

Robert DESBRANDES, inventor